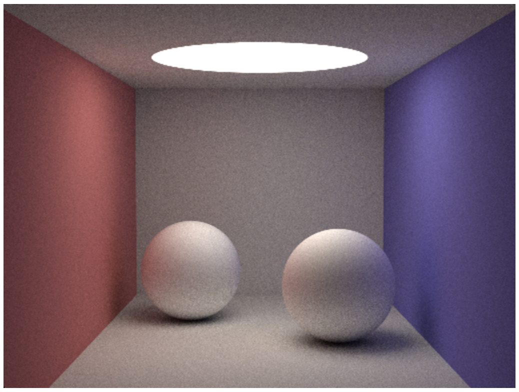
PHYSICALLY BASED RENDERING



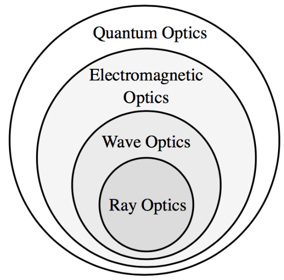


Figure 2.1: The theory of light is described by a series of increasingly complete optical models, where each successive model is able to account for more optical phenomena. In computer graphics and this dissertation, we will restrict ourselves to the simplest model, ray optics.

[https://cs.dartmouth.edu/wjarosz/publications/dissertation/chapter2.pdf]

RADIOMETRIC UNITS

$E_{photon} = hc/\lambda$

Specification	Definition	Symbol	Unit	Notation
# photons, energy		Q_e	[J= Ws] Joule	radiant energy
power, flux	dQ/dt	Φ_e	[W= J/s]	radiant flux
flux density	dQ/dAdt	E_e	[W/m^2]	Irradiance
flux density	dQ/dAdt	$M_e = B_e$	[W/m^2]	Radiosity
	$dQ/dA^{\Phi}d\omega dt$	L_e	[W/m^2/sr]	Radiance
intensity	$dQ/d\omega dt$	I_e	[W/sr]	radiant intensity

[https://resources.mpi-inf.mpg.de/departments/d4/teaching/ws200708/cg/slides/CG11-HumanVision.pdf]

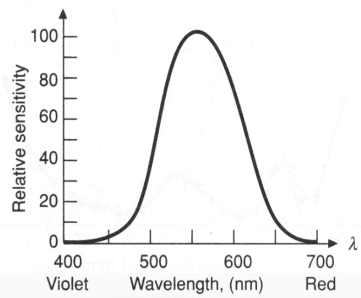
Photometry

- **Equivalent units to radiometry**
  - Weight with **luminous efficiency function** $V(\lambda)$ (luminous efficiency function)
  - Spectral or “total” units

$$\Phi_v = K_m \int V(\lambda)\Phi_e(\lambda)d\lambda$$

$$K_m = 680\ lm/W$$

  - Distinction in English simple:
    - “rad”: radiometric unit
    - “lum”: photometric unit



[https://resources.mpi-inf.mpg.de/departments/d4/teaching/ws200708/cg/slides/CG11-HumanVision.pdf]

PHOTOMETRIC UNITS

Specification	Definition	Symbol	Units	Notation
energy		Q_v	[talbot]	luminous energy
power, flux	dQ/dt	Φ_v	[lm (Lumen) = talbot/s]	luminous flux
flux density	dQ/dAdt	E_v	[lux= lm/m^2]	Illuminance
flux density	dQ/dAdt	[M_v=] B_v	[lux]	Luminosity
	$dQ/dA^{\Phi}d\omega dt$	L_v	[$lm/m^2/sr$] [nit] (cd/m^2)	Luminance
intensity	$dQ/d\omega dt$	I_v	[cd (candela) = lm/sr]	radiant intensity

[https://resources.mpi-inf.mpg.de/departments/d4/teaching/ws200708/cg/slides/CG11-HumanVision.pdf]

POINT LIGHT IN SPHERE

PHOTONS IN SPACE

TWO ELEMENT FLUX TRANSFER

TOTAL IRRADIANCE FROM RADIANCE

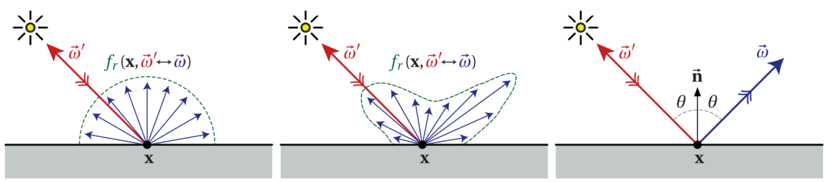
BIDIRECTIONAL REFLECTANCE DISTRIBUTION FUNCTION (BRDF)

Physically realistic BRDFs have additional properties,[2] including,

- positivity: $f_r(\omega_i, \omega_r) \geq 0$
- obeying Helmholtz reciprocity: $f_r(\omega_i, \omega_r) = f_r(\omega_r, \omega_i)$
- conserving energy: $\forall \omega_i, \int_\Omega f_r(\omega_i, \omega_r) \cos\theta_r d\omega_r \leq 1$

$$f_r(\omega_i, \omega_r) = \frac{d L_r(\omega_r)}{d E_i(\omega_i)} = \frac{d L_r(\omega_r)}{L_i(\omega_i) \cos\theta_i \, d\omega_i}$$

[https://en.wikipedia.org/wiki/Bidirectional_reflectance_distribution_function]



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